## (D) REMARKS

Introduction

Claims 1–42 are pending in the present patent application and all claims are rejected in this Office Action. The Examiner rejects claims 1–42 under 35 U.S.C. §103(a), as being unpatentable over Robertsson *et al.* (U.S. Patent No. US-6,775,618 B1) when taken in view of either one of Fokkema *et al.* (U.S. Patent No. US-6,477,470 B2) and Fokkema *et al.* (U.S. Patent No. US-6,747,913 B2).

Claims 1, 16, 26, and 33 are amended in this response, while claims 8, 10 – 15, 21, 32, and 38 are canceled. A complete set of claims, including amended claims, are presented above in Section (C) Amendments to the Claims.

Claim Rejections – Summary

Applicant cancels independent claim 10 and all its dependent claims 11–15, claims related to a method for only deghosting marine seismic data.

The remaining independent claims 1, 16, 26, and 33 are all related to a method for both deghosting and water surface multiple reflection attenuation in dual sensor marine seismic data. Applicant amends claims 1, 16, 26, and 33 to add the limitation that the "determining a substantially multiple-free wavefield from the decomposed wavefield components" is "by solving a system of equations for measured total wavefield and measured multiple free wavefield at the plurality of source positions". None of the prior art cited by the Examiner discloses this method for water surface multiple reflection attenuation. This amendment is explained in more detail below.

Thus, Robertsson *et al.* ('618), Fokkema *et al.* ('470), and Fokkema *et al.* ('913) neither teach nor suggest, alone or in combination, in an obvious way, a "method for deghosting and water surface multiple reflection attenuation in dual sensor marine seismic data" that includes "determining a substantially multiple-free wavefield from the decomposed wavefield components ... by solving a system of equations for measured total wavefield and measured multiple free wavefield at the plurality of source positions", as in the present invention, as

embodied in independent claims 1, 16, 26, and 33, as amended. Therefore, remaining independent claims 1, 16, 26, and 33 and all their remaining dependent claims are allowable.

Claim Rejections: Discussion

In the present Office Action, the Examiner rejects claims 1–42 under 35 U.S.C. §103(a), as being unpatentable over Robertsson *et al.* ('618) when taken in view of either one of Fokkema *et al.* ('470) and Fokkema *et al.* ('913).

Per independent claims 1, 10, 16, and 26, the Examiner states that Robertsson *et al.* ('618) discloses a system, method, and computer program for deghosting and water surface multiple reflection attenuation using pressure and vertical particle motion data. The Examiner states that Robertsson *et al.* ('618) discloses a spatial filter designed to effectively separate the up-going and down-going wavefield components of the seismic data. The Examiner states that the difference between claims 1, 10, 16, and 26 and Robertsson *et al.* ('618) is that the decomposition step specified in the claims takes place in the spatial Fourier domain and the up-going component is then inverse transformed into the spatial frequency domain.

The Examiner then states that the two Fokkema et al. patents each disclose utilizing the spatial Fourier transform to transform the pressure and vertical particle motion data into the spatial Fourier domain and inverse transforming the filtered or separated data back to the time domain. The Examiner states that it would have been obvious to modify Robertsson *et al.* ('618) by combining with the two Fokkema et al. patents. Additionally, per independent claim 33, the Examiner states that Robertsson *et al.* ('618) discloses the insensitivity of its method to streamer depth, thus allowing the streamer to be towed.

Applicant cancels independent claim 10 and all its dependent claims 11–15. These claims are all related to a method for only deghosting marine seismic data.

The remaining independent claims 1, 16, 26, and 33 are all related to a method for both deghosting and water surface multiple reflection attenuation in dual sensor marine seismic data (described as a method for seismic exploration or as a computer program in the preambles of the latter three claims). Applicant amends claims 1, 16, 26, and 33 to incorporate the (identical) contents of their dependent claims 8, 21, 32, and 38, respectively. Then claims 8, 21, 32, and 38, now redundant, are canceled. This amendment adds the limitation that the step of "determining a

substantially multiple-free wavefield from the decomposed wavefield components" is "by solving a system of equations for measured total wavefield and measured multiple free wavefield at the plurality of source positions".

Robertsson *et al.* ('618) discloses a method for decomposing marine seismic data into upgoing and downgoing wavefield components (see equation (1) for dual sensor data and alternative equation (4) for pressure sensor only data, along with the accompanying discussion in col. 6 of Robertsson). Robertsson's method is for attenuating noise (in particular, surface receiver ghosts) that is in the downgoing wavefield component (see, for example, col. 1, line 66 to col. 2, line 3 of Robertsson). The success of the decomposition in Robertsson depends upon constructing a spatial filter utilizing data recorded at a number of *receiver* positions (see, for example, col. 3, lines 4–18 of Robertsson). Robertsson states that the decomposed wavefield components are then ready for further processing and analysis, but does not disclose any particular further processing of the wavefield components (see, for example, the flowchart in Figure (8) and its discussion at col. 7, lines 41–64 of Robertsson).

Fokkema *et al.* ('470), and Fokkema *et al.* ('913) both disclose methods for deghosting marine seismic data, but not for multiple attenuation (see, for example, step 110 of the flowchart in Figure 1 and its discussion at col. 7, lines 1–59 of Fokkema ('470) or col. 7, lines 5-60 of Fokkema ('913), a division of Fokkema ('470)). The two Fokkema patents transform marine seismic data into the spatial Fourier domain (referred to as the "spectral domain" in the Fokkema patents) for mathematical simplicity, because "[t]he advantage to deghost in the spectral domain is that it consists of a simple division." (col. 7, lines 5–6 of Fokkema ('470) and col. 7, lines 9–10 of Fokkema ('913)) As in Robertsson, above, both of the Fokkema patents utilize data recorded at a number of *receiver* positions (see, for example, col. 7, lines 1–5 of Fokkema ('470) or col. 7, lines 5-9 of Fokkema ('913)).

In the present application, in contrast to the simple decomposition into upgoing and downgoing components utilized in the art cited by the Examiner, a system of differential equations is solved in the spatial Fourier domain at a plurality of *source* positions to calculate the up-going wavefield to determine a substantially multiple-free wavefield (equation (33) in paragraph [0076] on p. 7, as summarized in paragraph [0081] on p. 7 of the present application as given in its Patent Application Publication US 2005/0013194 A1). This additional computational step is made because "... at the depth in the water at which streamers are typically

towed, water layer multiples may include both upgoing and downgoing components, making directional discrimination difficult." (end of paragraph [0016] on p. 2 of the present Application Publication ('194))

Thus, Robertsson *et al.* ('618), Fokkema *et al.* ('470), and Fokkema *et al.* ('913) neither teach nor suggest, alone or in combination, in an obvious way, a "method for deghosting and water surface multiple reflection attenuation in dual sensor marine seismic data" that includes "determining a substantially multiple-free wavefield from the decomposed wavefield components ... by solving a system of equations for measured total wavefield and measured multiple free wavefield at the plurality of source positions", as in the present invention, as embodied in independent claim 1, as amended.

Similarly, Robertsson *et al.* ('618), Fokkema *et al.* ('470), and Fokkema *et al.* ('913) neither teach nor suggest, alone or in combination, in an obvious way, a "method for seismic exploration" that includes "determining a substantially multiple-free wavefield from the decomposed wavefield components ... by solving a system of equations for measured total wavefield and measured multiple free wavefield at the plurality of source positions", as in the present invention, as embodied in independent claims 16 and 33, as amended.

Similarly, Robertsson *et al.* ('618), Fokkema *et al.* ('470), and Fokkema *et al.* ('913) neither teach nor suggest, alone or in combination, in an obvious way, a "computer program ... containing logic operable to cause a programmable computer to perform steps" that includes "determining a substantially multiple-free wavefield from the decomposed wavefield components ... by solving a system of equations for measured total wavefield and measured multiple free wavefield at the plurality of source positions", as in the present invention, as embodied in independent claim 26, as amended.

The Examiner states that dependent claims 2–9, 11–15, 17–25, 27–32, and 34–40 are further provided for by the above combination of Robertsson *et al.* ('618), Fokkema *et al.* ('470), and Fokkema *et al.* ('913). However, since independent claims 1, 16, 26, and 33 are allowable, their (remaining) dependent claims 2–7, 9, 17–20, 22–25, 27–31, 34–37, and 39–40, are also allowable. Therefore, applicant believes that all remaining claims, as amended, are ready for acceptance.

Conclusion

Thus, Applicant believes that the preceding amendments to the claims place this application in condition for allowance. Applicant respectfully requests the favorable consideration and allowance of this application.

Respectfully submitted,

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Charles R. Schweppe, Reg. No. 38,612
Charles Schweppe, L.C.
8100 Cpresswood Drive, #1528
Spring, TX 77379-7197

Counsel of Record
E. Eugene Thigpen, Reg. No. 27,400
Petroleum Geo-Services, Inc.
P. O. Box 42085
Houston, TX 77242-2805
Telephone: 281-509-8368
Facsimile: 281-509-8085